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Abstract

It is increasingly recognized that urbanization is accompanied by profound changes in African diets. Some studies hold the hope that urbanization will help eradicate hunger and undernourishment, both still prominent issues in the region. Others have warned that urbanization may actually shift the problem from the left to the right tail of the food consumption distribution, with urban diets being dominated by high-calorie processed foods and an excessive intake of oil and sugar. Throughout the literature, most datasets simply provide aggregated nutritional information and lack the necessary level of granularity hampering investigation into these issues. Most studies also aggregate everything from small towns to megacities into a single 'urban' category, potentially missing important heterogeneity with respect to dietary change. This paper overcomes these problems by using a dataset of 1,498 households from Tanzania, each of whom completed a 2-week consumption diary that records detailed information on the quantity and characteristics of all food consumed. This allows us to calculate the macro- and micronutrient content of these diets. Dietary differences across urban and rural households are documented using OLS regressions and the doubly robust estimation method. These analyses are split into separate income groups to account for income heterogeneity. Our results caution against generalizations about urban diets as "right tail" theories have done. Firstly, we observe that the average urban household has a more wholesome diet indicating that micronutrient deficiencies are less prominent. This thus contradicts theories stating that urban diets are unhealthy. On the one hand, low and middle income urban households from our sample area meet the daily recommended values of most nutrients, making their diet more fulfilling compared to that of rural households. On the other hand, rich urban and rural households are found to overconsume, yet urban households tend to be less extreme. Secondly, when disaggregating urban areas into various categories, it is found that secondary towns present favourable diets and although larger cities such as Dodoma and Dar Es Salaam show higher levels of consumption, sufficient micronutrients are taken in and unhealthy substances do not reach alarmingly high levels.

Key words: Micronutrient Intake, Malnutrition, Urbanization, Secondary Towns, Tanzania

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1. Introduction

Developing countries are urbanizing rapidly. Urbanization is defined as the gradual shift of a population from rural to urban regions and, most importantly, the way society adapts to this change. This phenomenon is particularly evident in Sub-Saharan Africa, which has experienced the highest urban growth over the past two decades at 3.5% per year (UN Habitat, 2014). More crucially is that this rate is expected to last until 2050, making the effects of urbanization a very relevant topic today. Moreover, urban population clustering is predicted to have an array of consequences as rural urban migration is paired with changes in working and living conditions, lifestyles and incomes (Nguyen et al. 2013).

Hunger and malnutrition are still prominent issues in Sub Saharan Africa. From 2014 to 2016, approximately 218 million people, which equals to about 23% of the population, were hungry (FAO, 2016). More specifically, in Tanzania , around 30% of the population was not able to meet their basic food needs due to extreme poverty (Ecker & Qaim, 2011). On the one hand, some scholars believe urbanization can aid the eradication of undernourishment (Delgado, 2003; Huang & Bouis, 2004). Urban dwellers tend to consume higher amounts of meat, dairy products and fruits (Chernichovsky & Meesook, 1984; Bouis & Huang, 1996), in turn providing them with key nutrients. This is crucial as malnutrition also includes the phenomenon of "hidden hunger," highlighting the inadequate intake of vitamins and minerals. Micronutrient deficiencies are a main issue that can cause entire generations of a population to suffer from cognitive and physical issues, more severe illnesses and in some cases premature death (Peeling & Smart 1994; Pollitt, 1995; Grantham-McGregor, 2000; Berkman et al., 2002). These issues in turn lead to educational difficulties (Lozoff et al., 2000; Glewwe et al., 2001; Caulfield et al., 2006; Luo et al., 2012), lower future incomes (Dercon & Hoddinott, 2003; Bobonis et al., 2006; Halterman et al., 2001; Hoddinott et al., 2013) increased health costs (Barro, 1996; Shorr et al., 2008) and decreased life expectancies, each highly affecting the economic climate of the country. It is important to note that micronutrient deficiencies can also take place at the upper tail of food consumption and thus may not always be simple to trace.

On the other hand and most popular in today's literature, studies warn that urbanization may actually move consumption past the daily recommended intakes and lead to overconsumption. Popkin (1999) refers to the association between socioeconomic and demographic changes and the dietary structure as the "nutrition transition". More precisely, it has been argued that urban areas in lower income countries have shifted towards more energy intensive diets, dominated by processed 'fast-food' and higher oil and sugar intakes (Popkin, 1999;

2004). Moreover, an increase in the consumption of bread and a growing dependence on street foods is present in urban areas (Maxwell et al., 2000; Maruapula et al., 2011). A study of Dar-Es-Salaam, in Tanzania, found that street foods accounted for almost three-quarters of the total calorie intake of the urban poor and middle-income groups (Kinabo, 2004). Combined with a more sedentary lifestyle, this can lead to issues such as obesity and other nutrition related non-communicable diseases (Popkin, 1999; 2004; Popkin et al., 2012). Clark et al. (1995) furthermore state that urbanization and dietary changes do not necessarily lead to an improvement in nutrient patterns. Empirical evidence however, remains largely inconclusive.

Whichever theory proves to be more important, "analysing the impact of urbanization on diet structure is a key public health issue" (Popkin, 1999). Nevertheless, the rural-urban transition is relatively understudied in Sub-Saharan Africa and lacks understanding from a microeconomic perspective (De Brauw et al., 2014). In addition, despite the growing consensus on the crucial importance of nutrition for long-term health (Black et al., 2008; Bhutta et al., 2008), the majority of the literature continues to focus on urbanization's implications on the quantity rather than the quality of food consumption. As a result, the implications of urbanization from a micronutrient perspective are still poorly understood. In this light, it is notable that in Tanzania, stunting is a more prevalent issue than wasting (Mamiro et al., 2005) indicating that although enough calories may be consumed, micronutrient intake may still be lacking. This phenomenon highlights the importance of dietary quality analyses.

The aim of this paper is to ascertain on which side of the food consumption distribution rural and urban households in Tanzania find themselves by analyzing the micronutrient content of their diets. More explicitly, due to a highly specific survey (Beegle et al., 2012) detailing exact foods consumed by 1,498 households across a two week period in Tanzania, it is now possible to take an in-depth look at rural and urban diets, not only from a calorific perspective but also from a micronutrient perspective. This knowledge presents a first step in assessing whether rural-urban migration in Tanzania is likely to improve nutrition or result in problems of overconsumption. This paper will thus provide the first thorough empirical investigation of the differences in nutrient intakes between urban and rural settings in Tanzania, a country reflecting a wide range of Sub-Saharan African environments where, according to the FAO, the proportion of hungry people is highest and increasing (De Weerdt et al., 2014). Furthermore, Tanzania is also experiencing strong rates of urbanization (Morisset et al., 2014), making this an ideal country to study.

Firstly, the analysis will include OLS regressions, followed by a doubly robust estimation. For each method, the sample will be split into income groups, allowing a specific comparison between rural and urban households of similar income levels. These procedures indicate that in our study area urban households tend to face less nutritional deficiencies than rural households. At first sight it appears that urban households consume more fat and saturated fats however, these intakes do not reach alarmingly high levels and are actually necessary. Rich households in rural and urban areas tend to overconsume yet urban households do to a lesser extent, especially when it comes to unhealthy substances. Overall, the average urban household has a more wholesome diet. Thus, through a thorough decomposition of rural and urban diets at a micronutrient level, this analysis debunks “upper-tail consumption” theories firstly by finding that urban diets are not necessarily unhealthy in themselves. And secondly, that in comparison to rural diets, on average urban households are actually reaching their daily required intakes.

Urban areas are, however, not uniform in size and range from small towns to megacities, each with potentially different dietary patterns. To take this into account our study continues by separating rural and urban households into four categories, namely rural, secondary towns, Dodoma and Dar Es Salaam. Dar Es Salaam, Tanzania’s largest city with a population over 4 million, is thus separated out from other urban areas including Dodoma, with a population of 400 000, and smaller secondary towns. From this disaggregation of urban areas, it is found that households living in secondary towns tend to have the most fulfilling and healthy diet, possibly driving the positive urban results found from the binomial analysis. Households living in Dodoma and Dar Es Salaam consume similar or slightly more macronutrients compared to rural households yet also face some micronutrient deficiencies. These are not necessarily worse, but differ from rural household deficiencies. These results indicate that generally urban areas seem to provide a better hub to eliminate malnutrition. Even in large cities such as Dodoma and Dar Es Salaam, far less sugar is consumed and fat and saturated fat intakes are decent. From both the binomial and categorical analysis, our study finds that right-tail theories do not hold in our sample areas. These findings are particularly important for the proper targeting of efforts to tackle issues of malnutrition, and avoiding misallocation of resources to groups or areas where these issues are less pressing.

In this paper, Section 2 will explain the data used in our analysis and cover the methods used. Section 3 presents the results and Section 4 will illustrate some robustness checks.

2. Material and Methods

2.1. Data Description

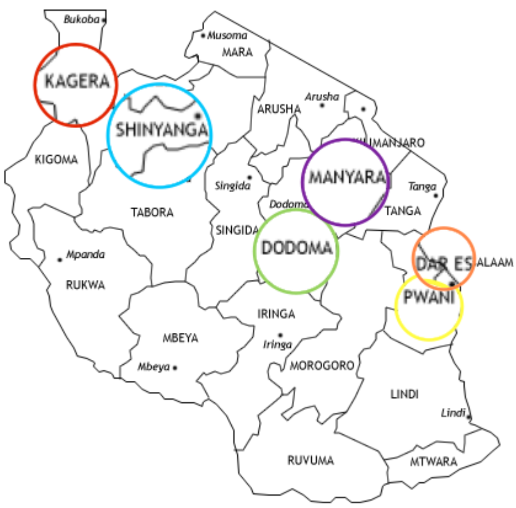
Throughout the literature, most data sets simply provide aggregate nutritional information yet this lacks the necessary level of nutritional decomposition to investigate the quality of a diet. In order to provide a more elaborate overview of nutrient deficiencies in rural and urban areas a highly detailed dataset is needed. The data used in this paper derives from a study by Beegle et al. (2012) assessing the net effect of questionnaire design using a survey experiment in Tanzania conducted from September 2007 to August 2008, officially named the Survey of Household Welfare and Labour in Tanzania. These surveys aimed to collect information on the effect different data collection techniques had on measuring poverty and hunger. In total, eight different designs were used varying in method of data collection, length of the period surveyed, level of the respondent, number of items on the recall list and type of the cognitive task required of the respondent. Five of the eight designs are based on recall modules and the remaining three are diary recordings. This paper will only use the household and personal diaries from this survey, as they are the only type of survey method that provides the amount of detail required for this analysis. The diaries specify a rich description of what households ate during the two weeks of surveying. It is due to these precise descriptions that it is possible to determine the nutrient intake of each household.

The survey experiment by Beegle et al. (2012) covered 4000 households from seven different districts, of which a total of 1510 households completed diaries. Overall, Tanzania is an ideal country to study as it reflects a wide range of Sub-Saharan African environments. The seven districts included are Dodoma, Pwani, Dar Es Salaam, Manyara, Shinyanga, plus two districts from the Kagera Region, shown in Figure 1. These locations were purposely selected to capture variations in socio-economic and geographic climate between different rural and urban locations. From these districts, communities were randomly selected from the 2002 Census, from which a random sub-village was chosen where all households were listed. Each district is subdivided into four regions, which in turn include 27 different clusters, or villages. In total, 24 households from each village were randomly chosen to participate with three households randomly assigned to each of the eight initial survey types.

The diary modules are of an acquisition type, meaning they add all products coming into the household through harvests, purchases, gifts and stock reductions as well as subtracting all items not consumed by the household through sales, stock increases and gifts. There are two types of household diaries each distinguished by varying the frequency of supervision by a trained survey staff member, namely weekly or daily supervision. These diaries use a single diary to record all household consumption. The personal diary method is where each adult member keeps their own diary and children are placed on the diary of the adult who best knows their consumption activities. These diaries should reduce the risk of double counting of purchases or self-produced goods. Interviewers were trained to crosscheck all diary submissions and carry out intensive supervisions every other day. Note that the personal diary is not an individual record but rather a record of food brought into the households by each member, which is consumed by several members daily. It must be noted that both household and personal diaries are used in order to include more observations into our analysis. These methods both present detailed descriptions of food consumption thus relevant for our study. As the diary survey methods differ slightly in implementation method, a control for survey type will be included in our regressions. In Section 4.3, a robustness check will further determine whether the results differ if only household or personal diaries are used.

Lastly, when taking a survey an issue may be that every household consumes portions and notates these in different units. In order to avoid unit conversion errors, households completed the food consumption diaries in local units, which are then converted into standard measures using item and region-specific food composition tables. These tables also take into account the edible portion of the food consumed. For example, a bunch of plantains leaves behind a considerable amount of non-edible stuffs and so this is acknowledged in the conversion tables[1].

Figure 1 | Survey Regions



[1] Conversion tables from Beegle et al. (2012)

2.2. Data Processing

Generally, consumer price index baskets consist of around 300 food items. Throughout the literature, this list is limited when recording consumption in order to simplify and shorten the process for respondents. On average, Living Standard Measurement Survey's contain 75 food groups (Beegle et al., 2012). Nonetheless, including a high level of detail is important as this prompts respondents into remembering accurate consumption. The original diaries from the Survey of Household Welfare and Labour in Tanzania (SHWALITA) are recorded on the basis of 58 food groups. Previous literature often simplifies food groups even further into representative groups such as cereals, starches, fruit, vegetables, meat and dairy products and so these 58 food groups are already considerably detailed. Nevertheless, throughout the SHWALITA survey households also documented the Swahili names for the specific foods consumed. This made it possible to disaggregate these 58 food groups even further by translating the Swahili words into English[2]. It was thus possible to separate the products present in the original 58 food groups by means of translation. It was established whether a food item in for example food group "tomatoes, onions, carrots" was a tomato, onion or carrot and so these three items were disaggregated into three separate groups. Although labour-intensive as spelling differences and dialects played a role, our final dataset now contains 100 different food groups.

It is important to note that these disaggregations can represent noteworthy differences for certain food groups. Originally, full meals and different types of snacks were grouped together. After separating the different types of full meals and snacks this disaggregation proved important. Rural areas tend to consume more nutritional rice meals containing higher levels of vitamins and minerals whereas urban dwellers tend to consume more calorie-dense oily porridges and street foods. Moreover, snacks also vary vastly as consuming a meat skewer equals to around 450 kcal whereas eating a roasted banana amounts to about 120 kcal. In terms of nutritional values, consuming a chapatti or samosa also differs greatly from eating a donut or cake. Sugar, fat and fibre contents differ greatly for these different types of snacks. Items such as water are also separated from its group originally including juices. When grouped together mean values between the two were taken as nutritional values to represent all items included within the group. As huge amounts of water are "consumed" (also used for animals and washing), these would portray high sugar intakes from juice if still grouped together. On the other hand, the

[2] Translations available upon request

sugar intake when consuming juice would be underestimated. An additional advantage of these disaggregations is that specific types of food are taken into account. For full meals for example, it is now possible to include methods of preparation and oils used, in turn giving a complete description of exact consumption.

A typical problem that may occur in this type of data collection is that of outliers. It is possible that households forget items or make mistakes in recording the units consumed and thus extremely low or high values of consumption may occur. In this paper outliers were accounted for at the grams level, prior to specific nutrient intake calculations. The outliers are corrected for at source level and then again at item level. The 100 food groups are separated into nine categories for which calorie restrictions were defined per capita per daily intake. These are in turn translated into maximum grams consumed per food group. A separate group for alcohol was created as higher amounts consumed easily lead to higher calorie intakes and thus may need higher restriction levels than other beverages. After calculating household specific nutrient intakes, households consuming less than 500 kcal per capita per day and more than 6500 kcal were deleted, leaving the study with 1498 households.

To aid data interpretation, this study will look at consumption relative to daily-recommended nutrient intakes and in turn nutrient deficiencies. To do this, calculations from Smith et al. (2006) are used to determine the daily-required calorie intake per household member where age, sex, breastfeeding and labour are taken into account. From this the mean per capita required calorie intake is computed per household. To determine the necessary macro- and micronutrients required per household member, the standard recommended values for a 2000 kcal diet were used and in turn transformed according to the household's mean recommended calorie intake. For example, a mean household required value of 2200 kcal would receive 10% more recommended nutrient intakes. Note that unhealthy nutrients such as saturated fat, cholesterol and sugars were kept at a maximum. For vitamins and minerals, it was also checked that the values did not exceed maximum intake levels.

Once the 100 different food groups are established, the author constructed a food composition table[3] for each food group including information on calories, protein, protein from meat, carbohydrates, fat, saturated fat, cholesterol, fibre, sugar, vitamins (A, B1, B2, B3, B6, B9, B12, C, E) and minerals (calcium, phosphorus, iron, sodium,

[3] Nutrient specific information collected from Tanzania food composition tables by Lukmanji, Z., Hertzmark, E., Mlingi, N., Assey, V., Ndossi, G., & Fawzi, W. (2008).. *MUHAS-TFNC, HSPH, Dar es Salaam Tanzania*.

magnesium, zinc and potassium). From these tables it will be possible to determine macro- and micro- nutrient intakes per household and thus compare rural and urban food consumption at a highly detailed level.

The data does nevertheless present some caveats. Firstly, although the surveying method employed accounts for food sold and given away as gifts, and edible portions are taken into account, the question will still remain whether all the food that was recorded was in fact consumed entirely. There is no mention of waste that is left after a meal. Nevertheless, this is fairly unlikely when analysing food consumption in developing countries as food waste in general is less common than in developed countries (FAO, 2011). Secondly, except for prepared snacks and meals, nutrients are recorded per food group according to the raw material. This means that nutrients lost during processing or meal preparation may not be accounted for. This problem is most evident when for example boiling vegetables for long periods of time causes them to lose some of their nutritional value. Here we risk underestimating deficiencies as fewer nutrients may be consumed than initially calculated.

2.3. Preliminary statistics

2.3.1. Food consumption patterns

Before breaking down rural and urban diets into macro- and micronutrients, Table 1 presents the average amount of calories consumed per food group by rural and urban households. It is found that cereals, roots and tubers such as cassava, sweet potatoes, rice, maize and plantains make up the majority of rural and urban diets. Pulses and nuts are also more frequently consumed in cities and towns. Urban households are furthermore found to consume more meat, fish and dairy products while rural households consume more fruits and vegetables. Popkin's theory on the nutrition transition may be indicated by these findings as sweets, soft drinks, snacks such as donuts and chapatti, and full, ready-made meals are far more common in cities. These food groups often include more fats and sugars. Nevertheless, a micronutrient decomposition will be able to deduce whether this theory holds. Lastly, it is found that alcoholic drinks are more readily consumed rurally. It must be noted that these values do not consider daily recommended intakes.

Table 1 | Average Calories Consumed per Food Group

	Rural	Urban
Cereals, roots and tubers	1764	1797
Pulses and nuts	207	279
Fruit and Vegetables	189	118
Meat and Fish	139	152
Milk products and fats	131	218
Sweets, hot drinks, soft drinks	107	157
Full Meals	117	201
Snacks	76	336
Alcoholic Drinks	134	103
Total	2864	3361

Moving on from what is most commonly consumed, Table 2 looks at the nutrient deficiencies present in rural and urban areas. These values are determined relative to daily recommended values taking gender, age, breastfeeding and type of labour into account. Note that here we do not account for the size of the deficiencies, as these are defined as soon as the mean household member consumes less than recommended daily values. Most noticeable from Table 2 is that hunger prevalence is about 20% higher in rural areas compared to urban areas. This can also be observed from the lower amount of macronutrient intake. It is however found that rural households fare better in some micronutrient intake such as Riboflavin, Niacin, Vitamin C, Calcium and Potassium. Other micronutrients are found to have no significant differences or are consumed more readily in urban areas.

Table 2 | Percentage of Nutrient Deficient Households

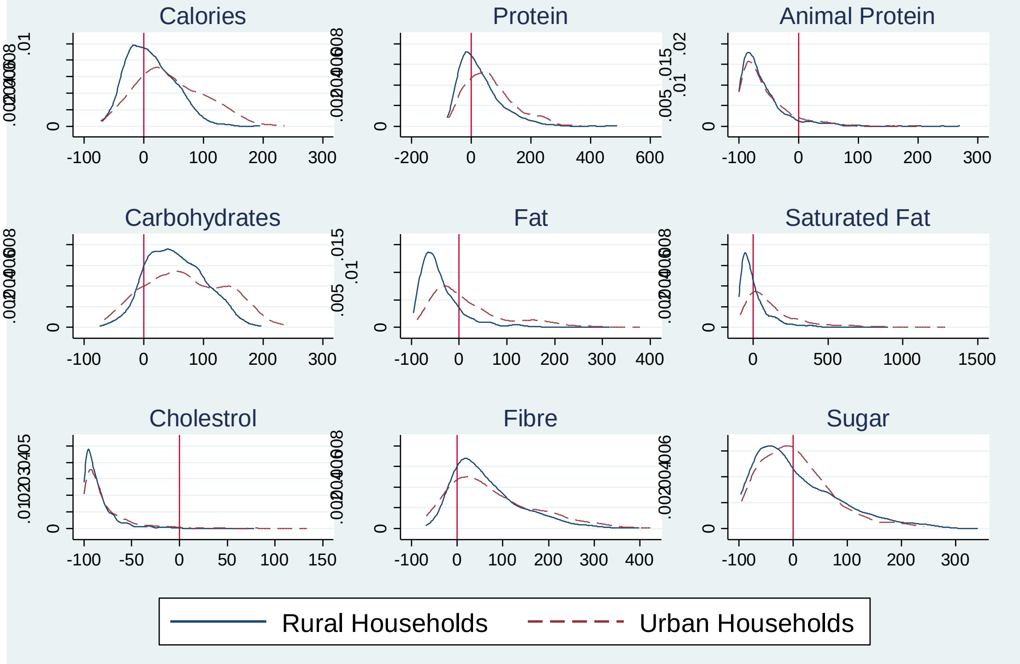
	Rural	Urban	P-value
Hunger prevalence	42.8	22.9	0.000***
Protein	40.8	24.8	0.000***
Animal protein	92.7	90.8	0.203
Fat	85.7	53.3	0.000***
Saturated fat*	61.3	24.2	0.000***
Cholesterol*	99.6	98.2	0.007***
Carbohydrates	11.7	16.6	0.008***
Sugar*	56.5	52.7	0.166
Fibre	18.3	20.5	0.292
Vitamin A	62.2	62.1	0.982
Thiamine	36.2	34.4	0.483
Riboflavin	28.5	20.9	0.001***
Niacin	36.2	28.3	0.002***
Vitamin B6	7.7	21.9	0.000***
Folate (ug)	58.0	60.0	0.468
Vitamin B12	74.8	52.1	0.000***

Vitamin C	23.5	47.1	0.000***
Vitamin E	53.8	56.4	0.321
Calcium	89.6	94.7	0.001***
Phosphate	16.6	9.8	0.000***
Iron	58.3	50.8	0.005***
Sodium	97.1	95.7	0.170
Potassium	38.8	65.8	0.000***
Magnesium	31.6	26.2	0.028**
Zinc	62.7	35.9	0.000***
N	986	512	

* Unhealthy substances and so a higher deficiency in this case is positive

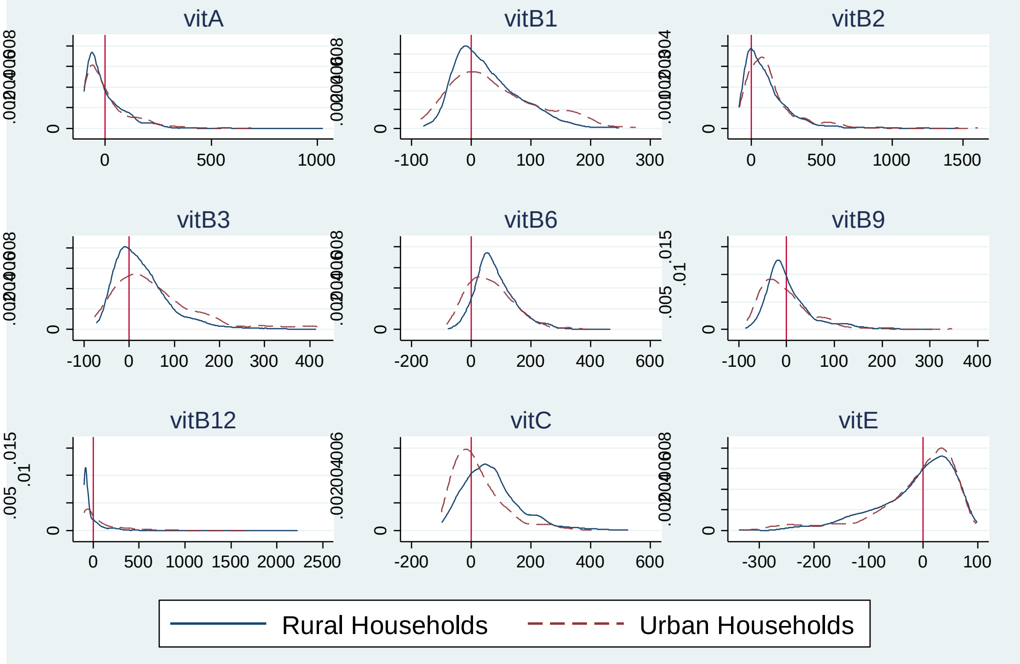
As Table 2 does not look at the extent to which some households underconsume, this information is available in Figure 2, Figure 3 and Figure 4 where the nutrient consumption distribution is given for each macro- and micronutrient considered in this analysis. From Figure 2, it is observed that urban households generally consume more macronutrients as the distribution is shifted slightly to the right of the rural consumption distribution. From these distributions, it is furthermore evident that unhealthy substance intake such as fat, saturated fat, cholesterol, and sugar are relatively underconsumed by both rural and urban households and so a higher consumption of these nutrients is not necessarily unhealthy. From Figure 3 it is found that vitamin intake is fairly similar in rural and urban areas. This indicates that although urban households may consume more macronutrients, these may be less micronutrient rich. When looking at Figure 4, urban households fare similarly or slightly better than rural households in terms of mineral consumption. Noticeable in the three figures is that the variance in the urban nutrient distributions is higher than that for rural households. This indicates that urban household diets differ more from each other than rural diets do.

Figure 2 | Rural and Urban Macronutrient Consumption Distribution



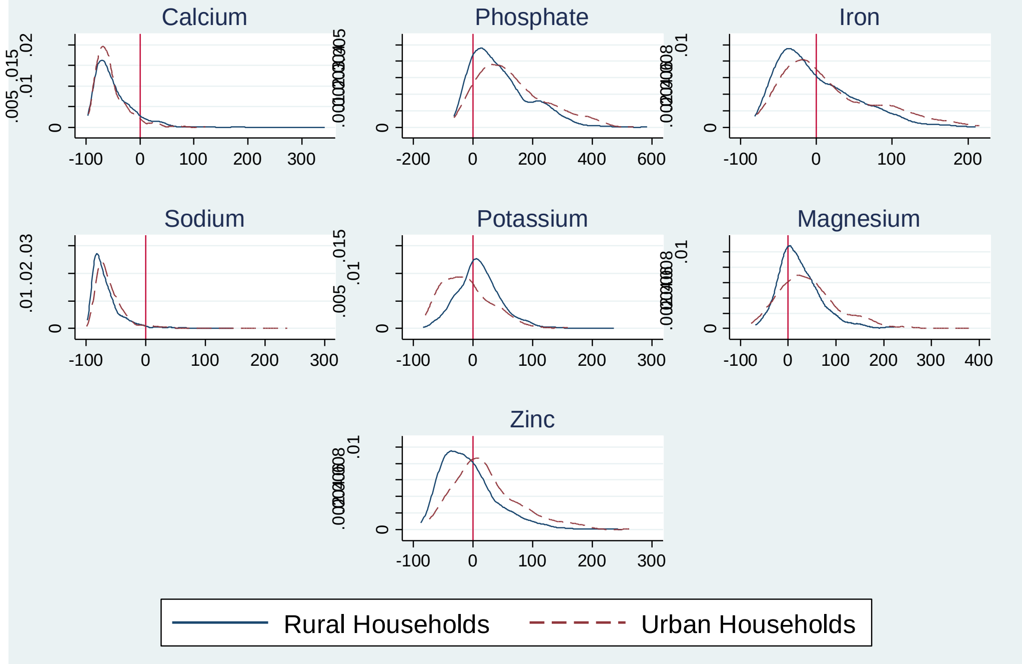
Note: Zero represents the daily recommended intake, negative values represent the percentage deficiency and positive values represent the percentage of overconsumption

Figure 3 | Rural and Urban Vitamin Consumption Distribution



Note: Zero represents the daily recommended intake, negative values represent the percentage deficiency and positive values represent the percentage of overconsumption

Figure 4 | Rural and Urban Mineral Consumption Distribution



Note: Zero represents the daily recommended intake, negative values represent the percentage deficiency and positive values represent the percentage of overconsumption

2.3.2. Household characteristics

After observing the differences in rural and urban household consumption, it is interesting to explore how these households differ in terms of demographic features. Household characteristics are displayed in Table 3. First of all, the average age of the household head in rural households is 2.7 years higher than urban households. On average, the household head has 4 years of education in rural settlements compared to 6 years in cities. Overall, the household size is also larger in rural areas. Urban households generally have more assets and consume nearly double the amount that rural households do. This is furthermore noticeable as there is a very large difference in non-food expenditure of rural and urban families. From this it is evident that rural households' income largely goes towards food and urban households split their income more equally between food and non-food items.

To include income into our analysis, total expenditure will be used as a proxy. Figure 5 portrays the two income per capita distributions, where it is obvious that the variance in income is much higher for urban compared to rural households. Both distributions are skewed to the left indicting that the majority of households are closer to a low than a high income. As income is a central factor in determining consumption patterns it is imperative to include this into our analysis. This will be done according to the income quartiles presented in Table 4. In Tanzania, when the survey was taken in 2007-2008, the mean household income is 1 944 364 TZS, which is equal to around 818 EUR. Figure 1A, in the appendix, shows the income distribution of rural and urban households at every income quartile. This shows that for poor, middle-rich and rich households the rural and urban households are similarly distributed. This means that results given in Section 3.1 are not driven by the possibility that urban households are at the top of the income category and rural households at the bottom. From the poor-middle income category, urban households are found more to the right of the rural households. The difference in nutrient consumption between poor to middle income rural and urban households could therefore still be driven by income.

As income plays a significant role in consumption, Figure 2, Figure 3 and Figure 4 are redone in order to establish nutrient intakes for all income groups. These figures[4] show us that in general rich households eat more and are more commonly found on the right hand side of the nutrient intake distribution, whereas poor households underconsume greatly and face extreme micronutrient deficiencies. It is thus imperative to analyse nutritional patterns between rural and urban households of similar income levels.

Table 3 | Household Characteristics

	Rural	Urban	P-value
Head female (dummy)	0.199	0.203	0.879
Head age	47.718	45.067	0.002***
Education head (years)	3.996	6.056	0.000***
Tech Education head (dummy)	0.089	0.245	0.000***
Household size	5.684	4.600	0.000***
Share of children <6	0.200	0.133	0.000***
Share children >6 <15	0.262	0.198	0.000***
Share children >16	0.080	0.067	0.204
Bicycle (dummy)	0.527	0.338	0.000***
Mobile (dummy)	0.171	0.571	0.000***
Good floor (dummy)	0.077	0.595	0.000***
Electricity (dummy)	0.004	0.313	0.000***
Asset index	-0.482	0.869	0.000***
Nominal consumption	1560639	2687294	0.000***
Acres land owned	4.432	2.652	0.000***
Total Expenditure Food	1208204	1612939	0.000***
Total Expenditure Non-Food	352434.4	1074356	0.000***
N	988	518	

p-value significance level ***0.01 **0.05 *0.10

[4] Available upon request

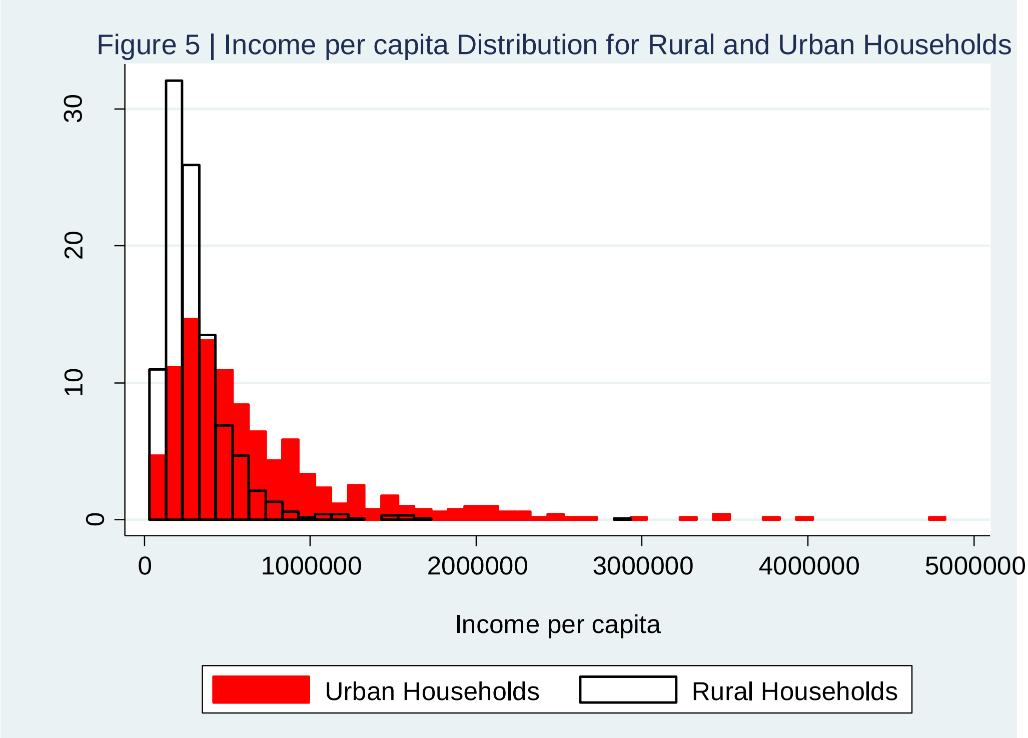


Table 4 | Income Quartiles

	Annual TZS	Euro
Minimum	152174.7	63.98
10%	558428.4	234.8
50%	1408753	592.33
90%	3740083	1572.58
Maximum	30600000	12866.24

Apart from household characteristics, community characteristics, displayed in Table 5, are also indicative. It is observed that more families migrated into urban areas than out of urban areas in the past year, meaning that the overall urban population in Tanzania has increased. There are, on average, more restaurants, shops, markets, banks and pharmacies in cities than in rural areas. These factors might firstly indicate a higher amount of home cooking in rural areas and more ready made and street food consumption in cities. On the other hand, financial and health issues will be more tasking for rural households. Lastly, it is found that both males and females work about half an hour more per day if situated in a rural area compared to the city.

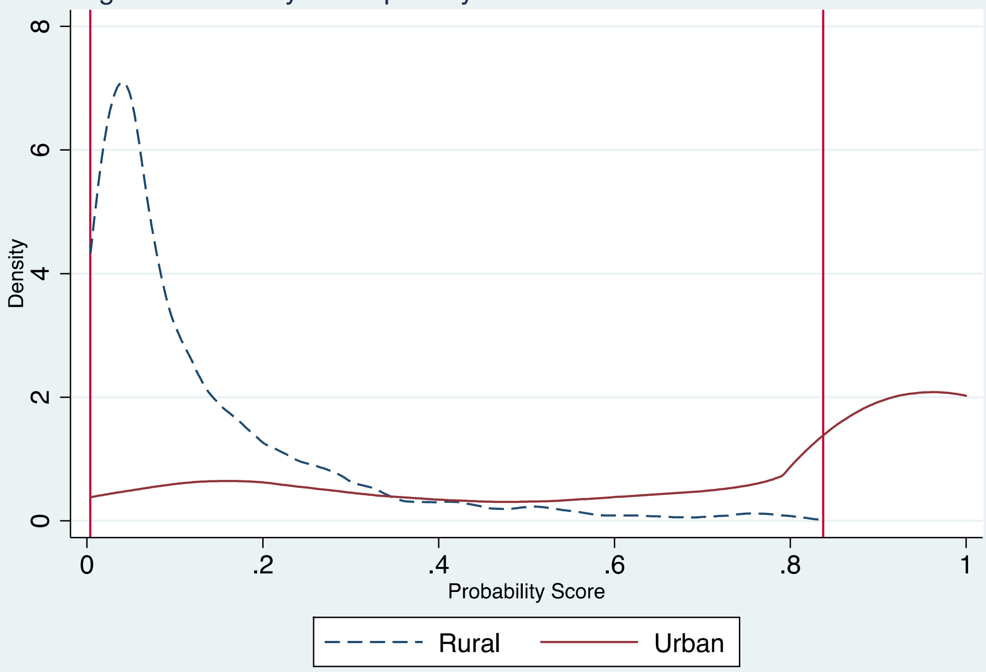
Table 5 | Community Characteristics

	Rural	Urban	P-value
Number households migrated out last year	4.071066	24.09766	0.000***
Number households migrated in last year	4.17665	30.37891	0.000***
Restaurant (dummy)	0.3417969	0.7654822	0.000***
Shops/stalls (dummy)	0.1054688	0.5736041	0.000***
Distance to shops/stalls	4.272566	3.5	0.176
Market (dummy)	0.65625	0.919797	0.000***
Distance to nearest market	7.471302	4.533835	0.000***
Bank (dummy)	0.2949219	0.8111675	0.000***
Day care centre (dummy)	1	0.9908629	0.030**
Pharmacy (dummy)	0.2578125	0.9208122	0.000***
Average hours of work (male)	7.424365	6.908333	0.390
Average hours of work (female)	7.387817	6.758333	0.294
Observations	985	512	

p-value significance level ***0.01 **0.05 *0.10

From these descriptive statistics it seems like rural and urban households differ greatly. Nevertheless, when calculating the propensity score of being an urban household and looking at the overlap in scores between rural and urban households, it is found that there are still a significant amount of households in rural and urban areas that share similar household and community characteristics. This overlap is presented in Figure 6 and thus indicates that an analysis of rural and urban diets is still of interest.

Figure 6 I Density of Propensity Score for rural and urban households



2.3.3. Urbanization disaggregated

After analysing the preliminary differences in rural and urban micronutrient intake, an interesting next step would be to differentiate between various levels of urbanization. These levels entail rural areas, secondary towns and the administrative and commercial capital of Tanzania, namely Dodoma and Dar Es Salaam. In Tanzania, there are vast differences between these areas. Dodoma, housing around 410,000 people (2012 Tanzania Population and Housing Census), cannot be compared with smaller secondary towns yet neither with Dar Es Salaam, Tanzania's growing metropolitan city with a population of almost 4.4 million. From Figure 7, Figure 8 and Figure 9, it is observed that in general nutritional deficiencies tend to improve between rural areas and secondary towns. More vitamins and minerals are consumed in secondary towns compared to rural areas and so these households face fewer deficiencies. From time to time nutritional intakes increase between secondary towns and Dodoma yet these are mostly well past recommended daily requirements thus diets are relatively fulfilling in both areas. Interestingly, it seems that nutrient consumption worsens when moving to Dar-Es-Salaam. Fat, saturated fat and sugar intakes are higher for Dar-Es-Salaam than the other areas, nevertheless, these values still prove that around 40% of the population underconsumes. Thus, although intakes may be higher they do not pose a significant health threat. Vitamin and mineral intakes vary. Note that "bad" nutrients such as saturated fats, cholesterol and sugar are preferred to have higher "deficiencies", or in other words, be further away from the daily maximum intakes. To accommodate these fascinating findings, this paper's analysis will not only focus on a binomial analysis but will also include a section allowing the exploration of these four different categories of urbanization.

Figure 7 | Macronutrient Deficiencies by Urban classification

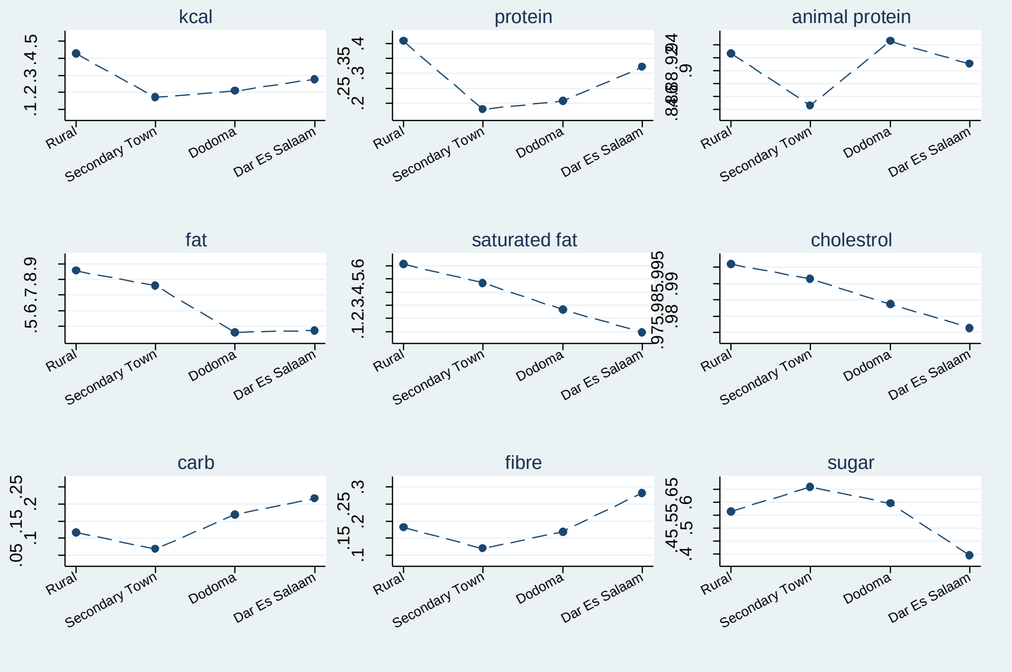


Figure 8 | Vitamin Deficiencies by Urban classification

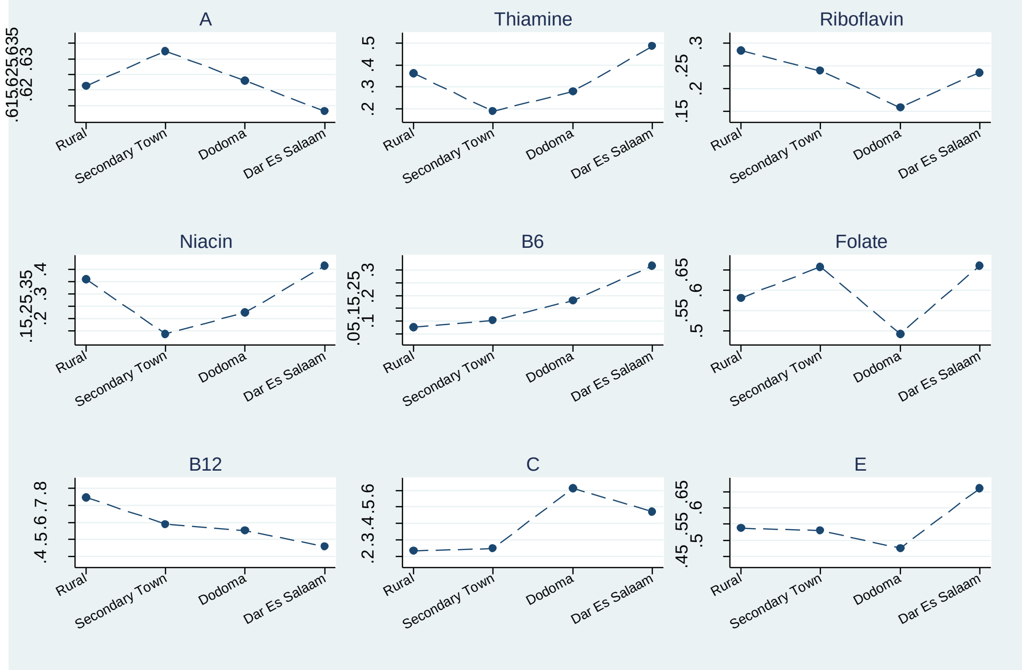
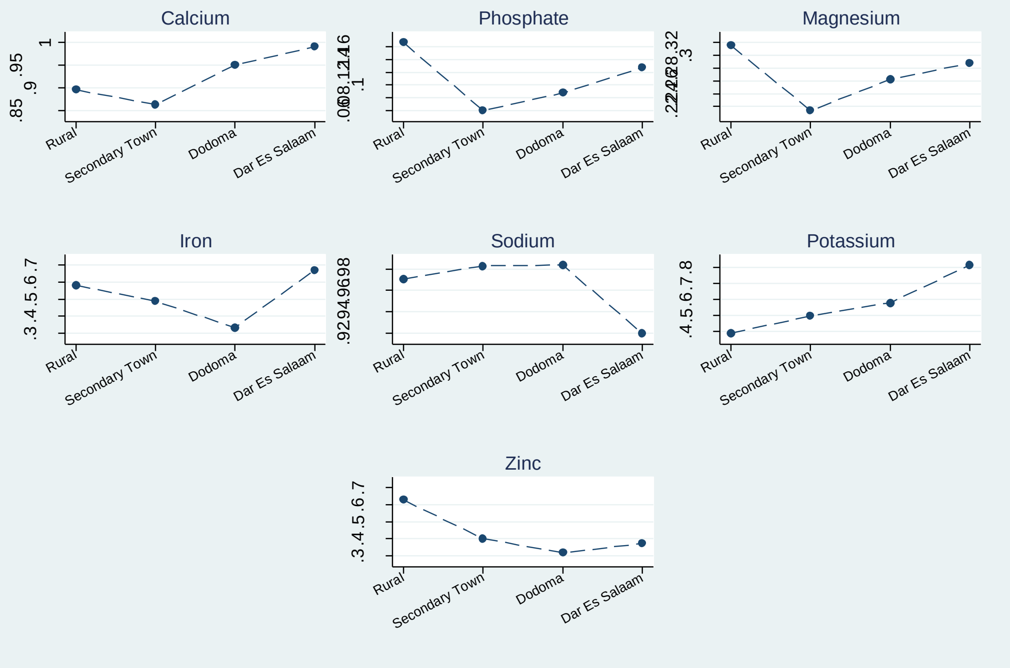


Figure 9 | Mineral Deficiencies by Urban classification



2.4. Methods

2.4.1. OLS

To start off the econometric analysis, OLS regressions will be run to indicate the effect urbanization has on calorie and nutrient intake. There are of course other factors that influence household consumption and so these must be controlled for. The characteristics that show a significant difference between rural and urban areas in Table 2 will be included in our regressions to control for the effect that these factors may have on dietary differences. Firstly, accounting for income is imperative as additional income can ensure higher diet diversity and improvements in the quality of food bought (Regmi & Meade, 2013). This remains important even within income groups. Moreover, poor households tend to lack appropriate cooking, refrigeration and storage facilities (Crush et al. 2011) thus tempering their ability to prepare sufficiently healthy meals. Income will be proxied for by household expenditures on food and non-food items. Income factors further encompass whether the household was interviewed during the harvesting or other seasons. Here, a control for month interviewed was added to account for seasonal income differences. Related to income are of course food prices. Chernichovsky and Meesook (1984) suggest that customary diets may be distorted by the differences in prices between rural and urban areas. To take this into account, a price index was created per district in our sample. Dodoma is used as the reference category.

Here it is observed that consuming an average diet in Pwani costs about 20% less than in the capital city. Both districts in Shinyanga and Kagera also show a significantly lower price index with prices being 40-46% cheaper in the former and 17-40% in the latter. Dar Es Salaam is the only district which is more expensive than Dodoma, with prices around 19% higher. As prices were only available at the district level, this means that village level price differences will not be taken into account and thus may present a certain bias in the results. This is however not a big problem as variations in price within a district are rather limited. These variations can be found in Figure 2A, in the appendix.

Additionally, household food consumption cannot fully be explained without looking at production and other supply side factors affecting food availability and diversity. Firstly, trade in food products has become increasingly more important as globalization and trade liberalization has taken place. Through the process of globalisation, supermarkets have become popular (Weatherspoon & Reardon, 2003), increasing variety and decreasing prices of food. Supermarkets have the possibility to promote higher quality diets (Tessier et al. 2008) however, Weatherspoon and Reardon (2003) find that in developing countries a higher focus is placed on packaged and processed foods. These supply-side determinants will be proxied for by the distance to markets, at the cluster level. This variable will also encompass the effects of advertising or in this case, the general consumption atmosphere in a certain cluster. This is a key element to explore as traditional eating patterns in Africa have been disrupted due to mass media influences (De Nigris, 1997). Crush et al. (2011) further argue that in Southern Africa media enhances the way in which food preferences are shaped, especially for poor urban households.

On top of household characteristic controls, various village controls will also be included in the regressions. Table 5 presents these community characteristics. Factors such as the area having a day care centre could affect female opportunity costs. Gender related factors must therefore be included in our regressions as conveniently consumed food has a higher demand in urban areas where both parents mostly work away from home and the cost of household help is greater than rural areas (Huang & David 1993). Lastly, lifestyle shifts will be captured by average hours worked by males and females and whether a restaurant is found close by. These lifestyle shifts are necessary as it is particularly evident that urban occupations tend to be less physically tasking (Ruel et al., 2010) as they shift away from high-energy requiring activities such as farming, mining and forestry towards the service sector (Popkin, 1999).

The OLS regressions will follow the equational form

$$y_i = \alpha + \beta Urban_i + \gamma \boldsymbol{X}_i + \epsilon_i$$

where y_i represents the dependent variable we want to analyse, namely the percentage deficiency of calories, macro- or micronutrient, $Urban_i$ is the dummy variable accounting for urbanization, $\boldsymbol{X}_i$ is the vector containing all household and community controls and ϵ_i is the error term. These regressions will be run per income group to account for heterogeneity issues.

To clarify, the dependent variables in our analysis are derived from the initial calculations for total household consumption over a time period of 2 weeks, given by the formula

$$totalconsumption = gramscons - gramsgift - animalcons + stockdecrease - stockincrease$$

where total consumption in grams is calculated as the total grams of food recorded by the household minus gifts and sold items, minus animal feed, minus increases in the households food stocks, plus the decreases of the household food stock indicating that food was consumed from here. These values were then transformed into a per capita, per day consumption by the formula

$$cons\_percap \ = \left(\frac{totalconsumption}{14 - missingdays}\right) / (hhsize - missingmembers)$$

This per capita per day food consumption in grams is calculated by dividing total consumption by the number of days the household recorded their food intakes, which is in turn divided by the number of persons present in the household during the two weeks. These per capita, per day grams of item specific consumptions were then merged with their item specific nutritional values. Then all values of all nutrients were added up in order to present the total amount of nutrients consumed per capita per day. From this it was possible to determine percentage consumption according to daily recommended values, for example for calories, by the formula

$$calories = (\left(\frac{meandailyrec - kcalcons}{meandailyrec}\right) * 100)(-1)$$

where $meandailyrec$ represents the mean calories required for a particular household and $kcalcons$ indicates the actual mean amount of calories consumed per capita per day by a household. Overconsumption is thus indicated by positive values and deficiencies indicated by negative values. This method is repeated for every macro and micronutrient.

2.4.2. Doubly Robust Estimation

When analysing a dataset of households, who either live in urban or rural areas, and attempting to establish differences in their consumption patterns, the issue of selection bias is naturally relevant. There are certain characteristics that households who live in towns or cities may possess that families living rurally may not. The decision of where to live is subject to many underlying factors and it is thus important to take these factors into account when analysing our data. The literature offers several estimation strategies to correct for selection bias (Heckman et al., 1999; Czarnitzki et al., 2007). These include the difference-in-difference estimator, selection models, instrumental variable estimation and non-parametric matching techniques. Firstly, a difference-in-difference method involves panel data with observations taken before and after treatment. The urban category will be referred to as the treatment group to resemble the terminology in the literature. As the dataset used in this paper consists of cross sectional data this estimator is not applicable here. Secondly, IV estimators and selection models require valid instruments for the treatment variables, which are not available in our data and otherwise very difficult to find. Therefore, the most suitable choice is the matching estimator. This estimator is obtained through a non-parametric process, thus omitting the difficulties of constructing a correct functional form nor is a distributional assumption on the error terms and the outcome equation necessary (Gerfin & Lechner, 2002). The issue with PSM is that this method only takes observable characteristics into account. Furthermore, PSM works under two conditions (Caliendo, M., & Kopeinig, S., 2008), which are too restrictive for this data.

To tackle these issues, doubly robust estimation will be used to refine our results (Bang & Robins, 2005; Funk et al., 2011; Waernbaum 2012). The principal behind doubly robust methods is that using inverse probability of treatment weighting (IPTW) in combination with normal OLS regressions allows the achievement of a consistent estimator as long as one of the two models is correctly specified (Joffe et al., 2012). Firstly, the propensity score is estimated as the conditional probability of finding households in the treatment group, in this case urban areas, according to certain observed characteristics. These scores are derived from a probit model following the form

$$URBAN_i = \beta_0 + \beta_1 X_1 + \cdots + \beta_n X_n + \epsilon_{it}$$

where the X_i variables represent the observed household and community characteristics. The propensity scores are then inversed giving us weights per household. In turn, these inverse propensity scores are used as weights in the regression giving more weight to households more likely to live in urban areas and less weight to households living rurally. The weights can be defined as follows (Austin, 2011)

$$w_i = \frac{Urban_i}{Score_i} + \frac{(1 - Urban_i)}{(1 - Score_i)}$$

where $Urban_i$ is the indicator variable indicating whether household i lives in an urban region and $Score_i$ presents household $i's$ propensity score.

This method is favourable under three conditions. First, the households are independent and identically distributed. Second, the selection process is exogenous, and third, the selection equation is properly specified. It is believed that these three conditions are fulfilled and thus this method is applicable in this paper's analysis. It must be noted, however, that the price of bias reduction through this method is an increase in random error, along with a downward bias in the nominal standard errors. This means that it may be that our results do not give significant results. Nevertheless, the dataset of households used in this study is suitably large and so this problem is not too much of a hurdle. Lastly, although doubly robust estimation provides higher chances in specifying a correct model, unmeasured confounding is still not taken into account.

2.4.3. Categorical analysis

As discovered during the preliminary statistics, simply using a rural urban division of households does not fully describe the different dynamics of urbanization and food consumption. It is important to consider various degrees of urbanization. This analysis will focus on OLS regressions including all the previously mentioned controls for household and community characteristics. Table 6 presents the sample size for each urban category.

Table 6 | Sample size per urban category

Urban category	Sample size	Percentage
Rural	985	65.8
Secondary Towns	117	7.82
Dodoma	183	12.22
Dar Es Salaam	212	14.16
Total	1497	100

The regressions will be run according to the following format

$$y_i = \alpha + \beta_1 SecondaryTowns_i + \beta_2 Dodoma_i + \beta_3 DarEsSalaam_i + \gamma \boldsymbol{X}_i + \epsilon_i$$

where y_i is the percentage consumption of the calories or nutrient of interest, each urban category is represented by a dummy with rural households as the references category, $\boldsymbol{X}_i$ includes all controls variables and ϵ_i is the error term.

It must be noted that although the regressions throughout the analysis are run including controls for other factors affecting dietary patterns, this dataset does not allow a thorough exploration of the channels influencing differences in food consumption between rural and urban households. No causal relationships can thus be deduced. Our data is, however, extremely useful in allowing us to analyse the exact nutrients consumed and so allows us to determine whether rural and urban diets are healthy and fulfil the daily required intakes.

3. Results

3.1. Binomial analysis

3.1.1. OLS

Table 7 presents the OLS regressions taken to establish several initial indications of the difference in nutritional intake and hunger between rural and urban households. All regressions include household and community characteristics to control for other possible influences on household consumption. First of all, it is found that urban households consume more calories across all income groups. The rural mean for poor households is well under the daily recommended intake. This indicates that especially for this group, urban households fare much better. This is also the case for poor-middle income households, as the rural mean is found around the recommended value thus indicating that still a substantial amount of households are found under this value.

The increased amount of calories consumed is in accordance with a higher intake of all macronutrients. At all income levels, except for rich households, a higher fat intake is positive as rural means lie under the daily recommended value. For rich households, the rural mean fat intake lies above the recommended intake yet urban households consume less than rural households. Rich urban households are also found to consume less saturated fat and sugar than rural households in the 10% richest households in the sample. This again proves a more wholesome and healthy diet for urban households compared to rural households. These findings contradict Popkin's theory on the nutrition transition as poor urban households consume more, which is necessary, and rich urban households consume in less extreme amounts than rural households.

When observing the micronutrients, the patterns parallel those of macronutrient intakes. Apart from vitamin A, urban households are on average better or similarly off as rural households in terms of vitamin intake. It is noticeable however that vitamin E intake decreases as income increases. This holds for both rural and urban families. Vitamins that are very important in crucial life stages such as pregnancies, for example vitamin B1 and B3, have less deficiencies in urban areas. Lastly, mineral consumption is also better for urban poor and middle income households compared to rural households.

Table 7 | OLS regression results: percentage consumption relative to daily recommended intake

VARIABLES	% kcal	% Protein	% Animal Protein	% Carbohydrates	% Fat	% Sat Fat	% Cholesterol	% Fibre	% Sugar
Poorest 10% Urban	34.45***	45.00***	-1.769	26.60**	38.05***	14.88	-0.923	50.00***	-22.33**
	(8.821)	(12.15)	(6.467)	(12.15)	(7.538)	(11.15)	(2.199)	(17.67)	(10.65)
Poorest 10% Rural Mean	-24.40	-18.85	-78.56	16.23	-73.71	-60.92	-93.89	23.87	-49.14
Poor-Middle 40% Urban	32.29***	47.92***	3.474	31.31***	30.82***	17.69	-1.349	53.70***	-27.02***
	(4.740)	(7.277)	(4.031)	(6.109)	(5.396)	(11.26)	(1.569)	(10.42)	(7.561)
Poor-Middle 10% Rural Mean	6.84	16.92	-69.92	52.45	-49.22	-18.59	-89.39	64.71	-10.79
Middle-Rich 40% Urban	58.30***	82.65***	-2.123	63.95***	49.31***	-15.83	-4.642	90.35***	-43.72***
	(6.757)	(12.70)	(7.738)	(7.885)	(10.25)	(21.35)	(3.343)	(13.63)	(12.53)
Middle-Rich 10% Rural Mean	30.33	60.05	-43.65	69.43	-16.55	64.91	-76.57	81.49	42.91
Richest 10% Urban	16.60	-91.22**	-91.59***	38.11	-100.1**	-327.1***	-14.81	10.25	-56.78
	(28.97)	(39.88)	(28.13)	(36.77)	(47.07)	(119.6)	(20.45)	(38.82)	(45.35)
Richest 10% Rural Mean	43.75	128.77	8.82	68.85	60.07	261.05	-46.54	94.74	144.82
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Community controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	140	140	140	140	140	140	140	140	140
	530	530	530	530	530	530	530	530	530
	402	402	402	402	402	402	402	402	402
	117	117	117	117	117	117	117	117	117

VARIABLES	% Vitamin A	% Vitamin B1	% Vitamin B2	% Vitamin B3	% Vitamin B6	% Vitamin B9	% Vitamin B12	% Vitamin C	% Vitamin E
Poorest 10% Urban	-78.98***	50.75***	-14.18	58.19***	12.77	7.481	5.865	-38.12	25.30
	(20.47)	(12.08)	(52.78)	(11.87)	(19.98)	(8.794)	(8.934)	(32.69)	(19.75)
Poorest 10% Rural Mean	-32.90	-3.91	62.53	-13.65	40.18	-28.55	-73.08	67.90	21.09
Poor-Middle 40% Urban	-41.07***	45.83***	50.56**	61.65***	28.38***	6.085	2.740	2.727	-1.117
	(12.48)	(7.171)	(21.41)	(8.545)	(8.028)	(6.033)	(21.10)	(13.62)	(8.957)
Poor-Middle 10% Rural Mean	-9.35	27.23	90.43	24.01	73.60	-2.76	-38.29	66.18	-6.91
Middle-Rich 40% Urban	25.64	79.30***	76.63**	121.2***	57.44***	35.53***	129.8***	18.22	-38.83***
	(17.91)	(9.223)	(34.72)	(14.29)	(12.83)	(11.20)	(31.47)	(16.65)	(14.67)
Middle-Rich 10% Rural Mean	26.47	39.71	146.41	51.52	106.13	29.20	36.51	79.39	-31.91
Richest 10% Urban	-45.11	36.76	-74.59	-20.59	-0.650	-19.45	-166.8	64.17	52.02
	(102.6)	(33.08)	(98.42)	(48.67)	(40.01)	(34.61)	(224.7)	(42.39)	(47.49)
Richest 10% Rural Mean	109.65	38.37	123.59	100.07	130.30	62.49	251.64	49.49	-72.75
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Community controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	140	140	140	140	140	140	140	140	140
	530	530	530	530	530	530	530	530	530
	402	402	402	402	402	402	402	402	402
	117	117	117	117	117	117	117	117	117

VARIABLES	% Calcium	% Phosphate	% Magnesium	% Iron	% Sodium	% Potassium	% Zinc
Poorest 10% Urban	0.486	82.33***	25.73**	41.76***	8.135	-5.337	27.91***
	(6.880)	(19.76)	(10.28)	(10.70)	(7.365)	(8.785)	(8.086)
Poorest 10% Rural Mean	-61.49	32.17	-14.34	-33.02	-80.96	-14.44	-46.58
Poor-Middle 40% Urban	10.98***	78.83***	20.91***	37.58***	3.599	3.417	13.66***
	(4.149)	(11.36)	(5.614)	(6.503)	(2.469)	(4.218)	(4.461)
Poor-Middle 10% Rural Mean	-53.87	84.24	18.55	-3.08	-72.07	6.26	-18.16
Middle-Rich 40% Urban	18.42***	142.8***	58.61***	68.69***	3.455	20.43***	40.33***
	(7.097)	(16.61)	(9.009)	(9.143)	(5.580)	(6.984)	(8.067)
Middle-Rich 10% Rural Mean	-35.49	124.46	42.91	16.31	-52.34	24.01	19.77
Richest 10% Urban	-96.72***	-45.66	0.520	-7.422	-29.60	-16.21	-65.49**
	(21.05)	(50.57)	(33.23)	(29.76)	(20.32)	(19.80)	(32.50)
Richest 10% Rural Mean	11.76	173.87	63.01	47.56	-16.16	40.51	97.87
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Community controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	140	140	140	140	140	140	140
	530	530	530	530	530	530	530
	402	402	402	402	402	402	402
	117	117	117	117	117	117	117

Robust standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

3.1.2. Doubly Robust Estimation

Table 8 portrays the results from the doubly robust estimation using propensity scores as weights in the regressions. Overall, these findings show similar patterns to those in Section 3.1.1., yet the magnitudes have altered. In general, the coefficients' magnitudes have increased when comparing rural and urban poor households and have decreased for the rest. This would emphasize the importance of urbanization especially for poor families who struggle to consume adequate amounts of food. The largest change in the results is seen for vitamin consumption amongst the urban rich. Here it seems that vitamin consumption has suddenly increased greatly. These results are however not reliable as the sample size for rich households was too small to create variation in propensity scores.

In conclusion, these results show similar patterns to the OLS regression. Firstly, more nutrients are consumed in urban areas when necessary, meaning for poor and middle income households. And secondly, less nutrients are consumed by rich urban households whereas rural areas face more issues of overconsumption.

3.1.3. Categorical analysis

In our categorical analysis the sample was split into various categories of urbanization in order to ascertain whether certain areas have a larger effect on nutrient intake than others. Here, it is no longer possible to divide our analysis up into the various income categories as our sample sizes would become too small. Income is nevertheless controlled for together with prices and all other household and community characteristics. From these results it is found that all categories of urban areas consume more calories than rural areas. These findings are backed by a higher macronutrient consumption. The rural mean for fat lies well under the daily recommended value, meaning that a higher fat intake is positive and necessary. This indicates a better diet in secondary towns and Dodoma. Saturated fat and sugar intake is situated around the daily maximum for the mean rural household. Here, most urban areas consume similar or less than rural households.

In terms of vitamins and minerals, it is observed that households residing in secondary towns have the most positive intake, indicating that deficiencies are less prevalent than in rural areas. For Dodoma and Dar Es Salaam, these values vary, sometimes being worse off or in a similar situation to rural households. These differences can be explained by the fact that secondary towns are still in close proximity to rural areas, meaning production value chains and markets are highly similar. Their diets could thus consist of similar foods but households in secondary towns may consume more, in turn allowing them to reach their daily recommended values. On the other hand, households living in Dodoma and Dar Es Salaam are likely to have a completely different diet, consisting of more street food and ready-made meals. Their fruit and vegetable intake is also different from that in rural areas, indicating the differences in vitamin and mineral intake.

Overall, households living in secondary towns are found to have the most wholesome and nutrient fulfilling diet. Rural households still tend to face issues of underconsumption and households living in Dodoma and Dar Es Salaam may still face issues of specific micronutrient deficiencies.

Table 8 | Doubly Robust Estimation results: percentage consumption relative to daily recommended intake

VARIABLES	% kcal	% Protein	% Animal Protein	% Carbohydrates	% Fat	% Sat Fat	% Cholesterol	% Fibre	% Sugar
Poorest 10% Urban	46.87***	52.58**	-5.312	52.90***	35.14*	9.681	1.206	66.74**	-16.51
	(14.32)	(21.84)	(7.267)	(18.38)	(18.85)	(12.06)	(3.430)	(27.55)	(9.964)
Poorest 10% Rural Mean	-24.40	-18.85	-78.56	16.23	-73.71	-60.92	-93.89	23.87	-49.14
Poor-Middle 40% Urban	27.17***	39.47***	3.029	31.05***	24.34***	4.847	-3.138	44.69***	-22.42***
	(7.668)	(8.988)	(5.976)	(8.346)	(6.838)	(10.65)	(2.683)	(14.27)	(7.126)
Poor-Middle 10% Rural Mean	6.84	16.92	-69.92	52.45	-49.22	-18.59	-89.39	64.71	-10.79
Middle-Rich 40% Urban	49.62***	54.66***	-23.71*	55.29***	56.74***	-13.39	-16.84**	73.30***	-16.66
	(12.72)	(18.13)	(13.29)	(11.96)	(14.61)	(28.12)	(6.512)	(22.54)	(17.16)
Middle-Rich 10% Rural Mean	30.33	60.05	-43.65	69.43	-16.55	64.91	-76.57	81.49	42.91
Richest 10% Urban	41.08**	22.38	-6.366	-16.16	3.370	-124.8	21.30	25.42	-96.97***
	(17.70)	(40.46)	(26.38)	(18.73)	(28.85)	(100.9)	(16.62)	(27.92)	(35.43)
Richest 10% Rural Mean	43.75	128.77	8.82	68.85	60.07	261.05	-46.54	94.74	144.82
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Community controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	140	140	140	140	140	140	140	140	140
	530	530	530	530	530	530	530	530	530
	402	402	402	402	402	402	402	402	402
	117	117	117	117	117	117	117	117	117

VARIABLES	% Vitamin A	% Vitamin B1	% Vitamin B2	% Vitamin B3	% Vitamin B6	% Vitamin B9	% Vitamin B12	% Vitamin C	% Vitamin E
Poorest 10% Urban	-56.05*	59.09***	-53.55	62.22***	-8.275	-4.339	-13.71	-77.53*	9.162
	(29.30)	(22.49)	(83.49)	(19.60)	(27.50)	(13.52)	(12.36)	(40.73)	(26.52)
Poorest 10% Rural Mean	-32.90	-3.91	62.53	-13.65	40.18	-28.55	-73.08	67.90	21.09
Poor-Middle 40% Urban	-57.67**	42.42***	38.67	56.93***	32.45***	12.29**	-51.69	45.41**	-6.550
	(24.28)	(9.375)	(31.17)	(11.73)	(10.31)	(6.145)	(55.57)	(20.62)	(11.48)
Poor-Middle 10% Rural Mean	-9.35	27.23	90.43	24.01	73.60	-2.76	-38.29	66.18	-6.91
Middle-Rich 40% Urban	27.57	69.31***	121.8*	111.5***	71.16***	63.38**	53.92	106.6**	-70.56**
	(39.51)	(15.00)	(68.85)	(23.87)	(20.01)	(27.41)	(64.15)	(43.56)	(28.44)
Middle-Rich 10% Rural Mean	26.47	39.71	146.41	51.52	106.13	29.20	36.51	79.39	-31.91
Richest 10% Urban	496.5***	51.55**	408.6***	87.11*	104.7**	125.0**	1,141***	170.4***	-62.52**
	(156.8)	(24.43)	(152.4)	(45.65)	(44.60)	(55.34)	(349.4)	(40.50)	(27.59)
Richest 10% Rural Mean	109.65	38.37	123.59	100.07	130.30	62.49	251.64	49.49	-72.75
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Community controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	140	140	140	140	140	140	140	140	140
	530	530	530	530	530	530	530	530	530
	402	402	402	402	402	402	402	402	402
	117	117	117	117	117	117	117	117	117

VARIABLES	% Calcium	% Phosphate	% Magnesium	% Iron	% Sodium	% Potassium	% Zinc
Poorest 10% Urban	-1.402	101.1**	26.26*	47.53**	4.624	-17.15	32.46*
	(10.52)	(41.77)	(14.55)	(20.71)	(5.834)	(12.10)	(17.61)
Poorest 10% Rural Mean	-61.49	32.17	-14.34	-33.02	-80.96	-14.44	-46.58
Poor-Middle 40% Urban	11.19**	61.71***	24.62***	27.80***	1.808	10.92**	12.57**
	(5.466)	(15.39)	(7.200)	(10.28)	(2.294)	(4.644)	(5.483)
Poor-Middle 10% Rural Mean	-53.87	84.24	18.55	-3.08	-72.07	6.26	-18.16
Middle-Rich 40% Urban	14.04	104.4***	72.23***	53.33***	-4.370	37.19***	36.36***
	(8.700)	(28.49)	(15.29)	(19.25)	(9.285)	(13.12)	(13.20)
Middle-Rich 10% Rural Mean	-35.49	124.46	42.91	16.31	-52.34	24.01	19.77
Richest 10% Urban	15.02	75.71	64.16**	35.52	61.07**	75.61**	12.10
	(22.25)	(47.33)	(31.05)	(27.40)	(25.50)	(28.91)	(30.93)
Richest 10% Rural Mean	11.76	173.87	63.01	47.56	-16.16	40.51	97.87
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Community controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	140	140	140	140	140	140	140
	530	530	530	530	530	530	530
	402	402	402	402	402	402	402
	117	117	117	117	117	117	117

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 9 |Categorical Urban Classification OLS regression results: percentage consumption relative to daily recommended intake

VARIABLES	% kcal	% Protein	% Animal Protein	% Carbohydrates	% Fat	% Sat Fat	% Cholesterol	% Fibre	% Sugar
Secondary Towns	34.25***	45.47***	11.07**	36.25***	30.38***	27.55*	1.308	26.22***	-4.874
	(5.019)	(8.038)	(4.534)	(6.081)	(6.596)	(14.83)	(2.193)	(9.099)	(7.580)
Dodoma	45.66***	60.80***	-20.28***	43.94***	36.81***	-51.39***	-9.313***	103.8***	-66.91***
	(5.560)	(8.906)	(5.023)	(6.737)	(7.308)	(16.43)	(2.430)	(10.08)	(8.398)
Dar Es Salaam	35.68***	49.31***	-18.83***	38.68***	1.405	-68.37***	-11.09***	87.41***	-116.6***
	(7.993)	(12.80)	(7.221)	(9.685)	(10.51)	(23.63)	(3.493)	(14.49)	(12.07)
Rural Mean	12.15	30.29	-59.92	54.38	-38.25	11.96	-84.45	66.29	6.97
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Community controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1304	1304	1304	1304	1304	1304	1304	1304	1304

VARIABLES	% Vitamin A	% Vitamin B1	% Vitamin B2	% Vitamin B3	% Vitamin B6	% Vitamin B9	% Vitamin B12	% Vitamin C	% Vitamin E
Secondary Towns	7.673	35.69***	-4.205	51.11***	28.44***	11.52*	58.33**	39.84***	-12.81
	(12.49)	(6.446)	(21.01)	(8.681)	(8.189)	(6.502)	(23.36)	(11.32)	(8.891)
Dodoma	-44.19***	80.64***	126.0***	113.3***	42.32***	15.24**	51.62**	-43.49***	-4.880
	(13.84)	(7.141)	(23.28)	(9.618)	(9.073)	(7.203)	(25.88)	(12.54)	(9.850)
Dar Es Salaam	-97.15***	61.70***	218.2***	54.89***	14.22	-0.497	8.697	-30.59*	49.44***
	(19.90)	(10.27)	(33.47)	(13.83)	(13.04)	(10.35)	(37.20)	(18.03)	(14.16)
Rural Mean	3.07	28.07	107.69	30.79	82.29	6.56	-9.69	70.76	-13.78
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Community controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1304	1304	1304	1304	1304	1304	1304	1304	1304

VARIABLES	% Calcium	% Phosphate	% Magnesium	% Iron	% Sodium	% Potassium	% Zinc
Secondary Towns	8.206*	64.45***	25.71***	21.89***	-1.012	10.46**	24.19***
	(4.207)	(10.93)	(6.018)	(5.975)	(3.238)	(4.349)	(5.365)
Dodoma	6.854	128.4***	41.69***	73.98***	4.224	1.082	15.92***
	(4.661)	(12.11)	(6.668)	(6.620)	(3.588)	(4.819)	(5.944)
Dar Es Salaam	17.18**	114.9***	30.88***	59.84***	22.04***	-20.60***	1.053
	(6.700)	(17.41)	(9.585)	(9.516)	(5.157)	(6.927)	(8.544)
Rural Mean	-46.85	94.07	24.13	1.22	-64.93	10.77	-5.65
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Community controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1304	1304	1304	1304	1304	1304	1304

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

4. Robustness Checks

4.1. Overall population results

As our binomial analysis has been split up into various income categories, the sample size per regression has decreased substantially. It would therefore be informative to re-do the analysis when using the entire sample. As the sample is now aggregated it is found that rural mean intakes have increased as they now take mean values of poor and rich households. Nevertheless, it is evident that there are still multiple households who do not reach their daily recommended intakes. The findings obtained from this analysis support the results found in Section 2.4.1. and Section 2.4.2. Urban households are still found to consume more macronutrients and micronutrients, thus making their diets more fulfilling[5].

4.2. Adult Equivalent

Throughout our analysis nutrient consumption per capita has been used as the initial unit of measure from which deficiencies are calculated. Originally, the household size was used in order to divide the total consumption per household into per capita consumption, as seen in Section 2.4.1. This may however not be entirely representative as households can vary largely in composition and this may even differ substantially between rural and urban areas. Children, adults and elderly persons do not require similar amounts of food and nutrients. Therefore, in order to make our study as detailed and specific as possible, the analysis will be repeated using the adult equivalent measure instead of household size in our initial formulas presented in Section 2.4.1. The adult equivalent is calculated according to different age groups and gender (Claro et al., 2010). The adult equivalent conversions can be found in Table 1A in the Appendix. The preliminary statistics, previously shown in Table 2 are represented in Table 2A, in the Appendix. Compared to Table 2, we find that the percentage of households with nutrient deficiencies increase by about 0.5% for the rural households yet deficiencies for urban households stay about the same. Overall, no large differences are found.

[5] Results will be made available in an online appendix. In the meantime, these are available upon request.

4.3. Diary Type Separation

As the data used in this paper is collated from three different types of diary surveys, it would be interesting to see whether the results remain the same when running the analysis on the various types of diaries individually. Firstly, the division between household and personal diaries may present differences. Secondly, the amount of supervision given to the households throughout the survey period may also affect the results due to the fact that households receiving more regular guidance and check-ups are more likely to correctly record all of their food consumption.

Here, the results will be compared to the results found in section 4.1., portraying the urbanization effect on nutrient consumption without splitting the sample into different income quartiles. From the OLS results[6], it is found that separating the different survey types generally does not largely affect the patterns found above. Urban households are still found to consume more. From our doubly robust results, it is observed that when only using personal diaries, the calorie consumption differences between rural and urban households are smaller and no longer significant. Nevertheless, the two household diaries show similar results to Table 7.

Whilst using the same methods as previously run, it is found that although magnitudes differ slightly, the general patterns of the results remain the same for each diary type. It is furthermore evident that significance levels are less strong, which can be explained by the smaller sample sizes. This is especially relevant splitting the sample into four categories of income levels as now each category decreases in size by a substantial amount. It is thus in our best interest to include all three diary types used in our initial analysis as the results remain similar but significance levels are better.

[6] Available upon request

5. Conclusion

Throughout the literature it is evident that micronutrient deficiencies are a great factor influencing a person's health, productivity and earning potential. In turn these deficiencies highly influence the economic climate of a country. On top of this is the discussion of urbanization and the differences in dietary patterns it brings along. The results from this paper indicate that low to middle income rural households on average consume fewer calories, macro- and micronutrients compared to poor to middle income urban households. More specifically, urban households seem to experience less vitamin B1, B3, B6, B9 and B12 deficiencies. Other vitamins are found to be consumed in similar amounts to rural households or there is an insignificant difference. Furthermore, low and middle income urban households also consume more or insignificantly different amounts of all the minerals recorded. Poor and middle income households thus fare better in urban settings in terms of nutrient intakes. Rich urban and rural households are faced with issues of overconsumption, although the levels are much higher rurally than in urban clusters. This indicates that the urban rich are more likely to mediate their overconsumption and thus have a relatively healthier diet.

When testing whether these results could be driven by certain levels of urbanization, it was found that although households living in secondary towns seem to have the most optimal diet, households in Dodoma and Dar Es Salaam still seem to have a more nutrient fulfilling diet than rural households. Apart from a lack in Vitamin A, Vitamin C and Potassium, households in Dar Es Salaam have a relatively healthy diet and are less likely to face hunger issues. Households living in Dodoma seem to reach their daily recommended values yet may sometimes consume too much.

From the results it is evident that nutritional issues must be addressed differently in rural and urban areas. For regions where micronutrient deficiencies are dominant White and Broadley (2011) suggest genetic biofortification to increase calcium levels in the leaves of Brassica spp., onion, spinach and the roots of carrots, cassava and plantain. Furthermore, Broadley and White (2010) add that specific grain fertilization could alleviate some zinc deficiencies. Overall, interventions such as the promotion of breastfeeding, increased child and development programmes and nutritional supplements to schoolchildren are seen to be highly beneficial (Behrman et al., 2004). Lastly, Joy et al. (2013) show that supply-based methods can be implemented in order to tackle the hidden hunger of developing countries.

Nonetheless, dietary diversification would not address the entire problem of nutritional deficiencies, as can be found in some urban regions, where supermarkets are more numerous yet micronutrient deficiencies are still evident. In areas such as Dar Es Salaam, knowledge based interventions on the importance of food and supermarket transformations from processed foods to fresh foods are more likely to have an impact. Reardon (2016) states that “to meet booming urban demand, the world’s food producers and food systems will need to transform themselves to deliver a safe, sustainable and nutrition food supply to growing cities. And care must be taken to ensure that farmers and rural economies can benefit – rather than be excluded – from this transformation.” There is thus a need to improve traditional complementary foods in terms of energy density and the bioavailability of macro and micronutrients.

Overall, this paper finds that low and middle income rural households suffer from more micronutrient deficiencies most likely related to under consumption in general. As less calories and macronutrients are consumed, this implies a lack of micronutrient intakes as well. Urban households, on the other hand, consume more food as a whole, thus reducing the chances of micronutrient deficiencies. Rich households are found to face issue of overconsumption yet these are less prominent in urban areas. In general, it is thus possible to say that theories indicating that urbanization leads to an unhealthy diet can be questioned, as urban households in Tanzania are found to have a more fulfilling diet, more likely to meet daily recommended intakes. In this case, it must be noted that urbanization may be a driving factor in the hope to eradicate hunger and undernutrition, and that fears for overconsumption remain negligible, especially as rich urban households are found to consume less than the rural rich.

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Appendix

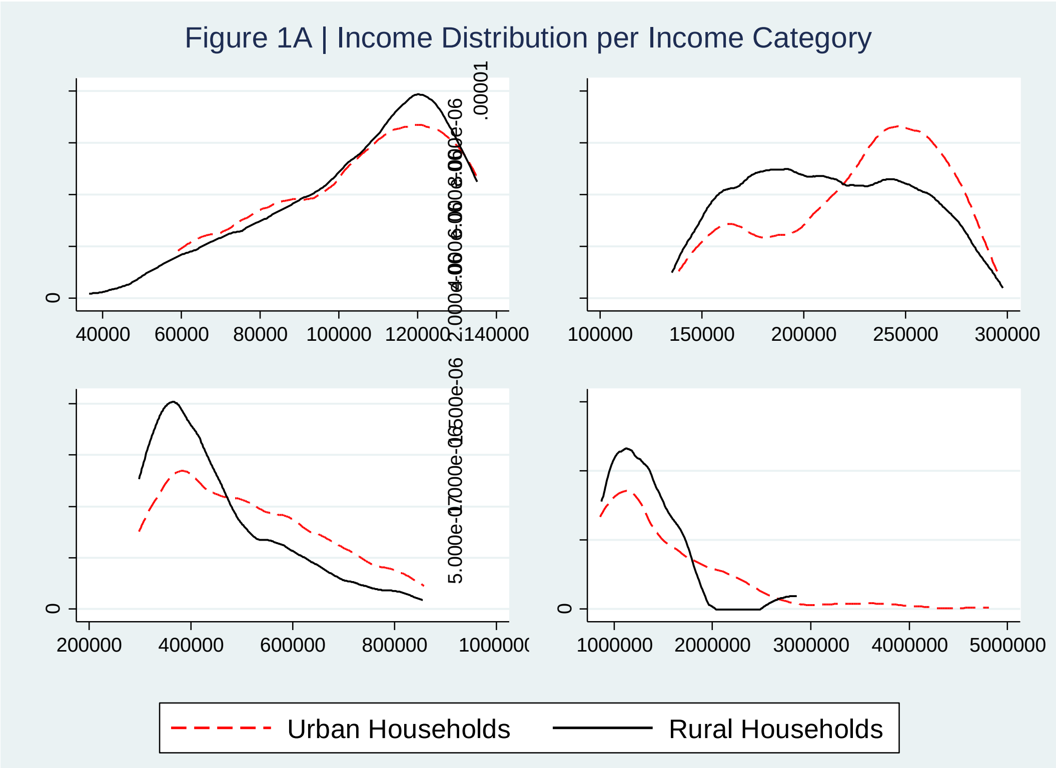

Figure 1A | Income Distribution per Income Category
Urban Households
Rural Households

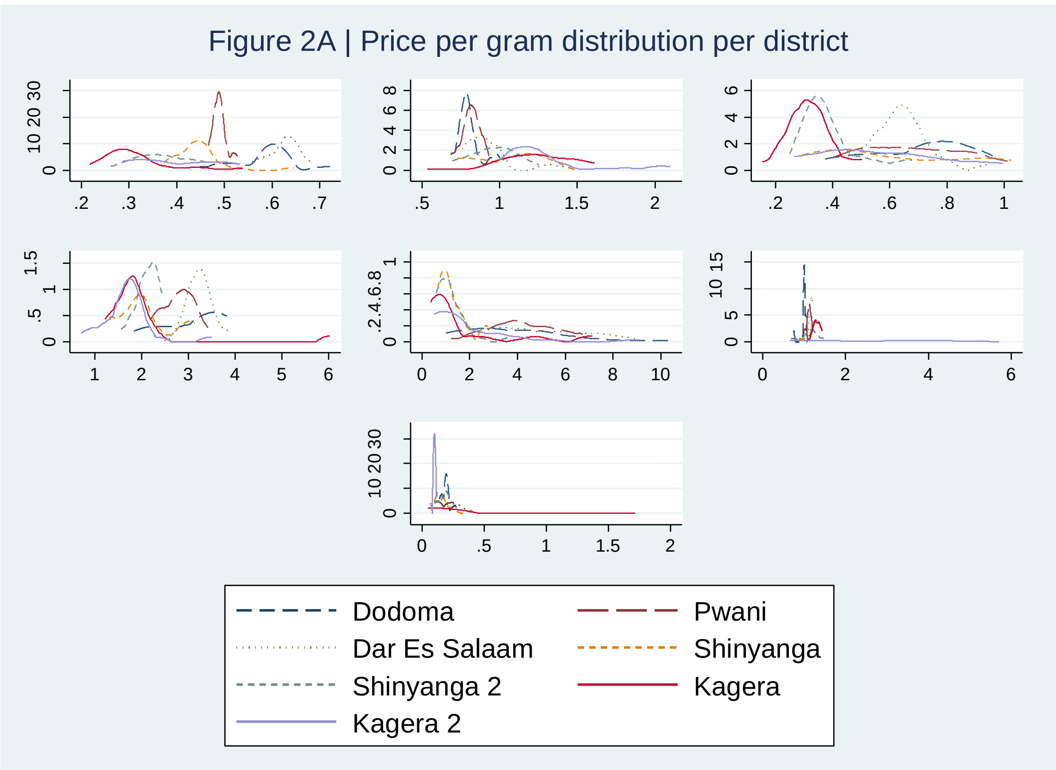

Figure 2A | Price per gram distribution per district
Dodoma
Pwani
Dar Es Salaam
Shinyanga
Shinyanga 2
Kagera
Kagera 2

Table 1A | Adult equivalent conversion factors for estimated calorie requirements according to age and gender

Age (years)	Calories (kcal)	Adult equivalent conversion factor
0-1	750	0.29
1-3	1,300	0.51
4-6	1,800	0.71
7-10	2,000	0.78
Men		0.98
11-14	2,500	1.18
15-18	3,000	1.14
19-24	2,900	1.14
25-50	2,900	1.14
51+	2,300	0.90
Women*		
11-14	2,200	0.86
15-18	2,200	0.86
19-24	2,200	0.86
25-50	2,200	0.86
51+	1,900	0.75
Breastfeeding women +500 kcal		
11-14	2,700	1.06
15-18	2,700	1.06
19-24	2,700	1.06
25-50	2,700	1.06
51+	2,400	0.94
Pregnant women +300 kcal		
11-14	2,500	0.98
15-18	2,500	0.98
19-24	2,500	0.98
25-50	2,500	0.98
51+	2,100	0.82

Table 2A | Percentage of Nutrient Deficient Households (Adult Equivalent)

	Rural	Urban	P-value
Hunger prevalence	43.2	22.8	0.000***
Protein	41.2	24.8	0.000***
Animal protein	92.7	90.8	0.203
Fat	85.8	53.3	0.000***
Saturated fat	61.3	24.2	0.000***
Cholesterol	99.6	98.2	0.007***
Carbohydrates	12.5	16.6	0.032**
Sugar	56.4	52.7	0.166
Fibre	18.9	20.5	0.472
Vitamin A	62.2	62.1	0.982
Thiamine	37.4	34.4	0.245
Riboflavin	28.6	20.9	0.001***
Niacin	37.2	28.3	0.000***
Vitamin B6	8.2	21.9	0.000***
Folate (ug)	58.4	59.9	0.565
Vitamin B12	74.8	52.1	0.000***
Vitamin C	23.5	47.3	0.000***
Vitamin E	54.2	56.4	0.420
Calcium	89.7	94.7	0.001***
Phosphate	17.1	9.8	0.000***
Iron	58.3	51	0.002***
Sodium	97.1	95.9	0.11
Potassium	39.6	66	0.000***
Magnesium	32.7	26.4	0.028**
Zinc	63.4	35.9	0.000***
N	986	512	

Note: this table displays the percentage of households in rural and urban areas who are nutrient deficient